In re Appln. Of: David Layden et al.
Application No.: 10/031,815

AMENDMENTS TO THE CLAIMS

1. (Original) A non-invasive method of monitoring operational readiness of electric power storage batteries in an uninterruptible power supply (UPS) system, the UPS system having at least one battery channel, each having at least two battery packs coupled in series to supply output power to a connected load and a battery charger to maintain and restore charge to the batteries during normal utility line operation, comprising the steps of:

monitoring a voltage at a midpoint between the two battery packs during a quiescent state of operation of the battery packs;

comparing the voltage to a first nominal value for the midpoint voltage during the quiescent state of operation of the battery packs;

indicating a lack of operational readiness of both battery packs when the voltage at the midpoint is less than the first nominal value by a first predetermined amount.

2. (Original) The method of claim 1, wherein the UPS system includes a plurality of battery channels coupled in parallel with one another, and wherein the step of monitoring comprises the step of monitoring a voltage for each of the parallel coupled battery channels at a midpoint between the two battery packs during a quiescent state of operation, the method further comprising the steps of:

calculating the first nominal value for the midpoint voltage during the quiescent state of operation of the battery packs as the average of the voltages monitored for each parallel coupled battery channel; and

indicating a lack of operational readiness of a battery channel when the voltage at the midpoint of the battery packs for that channel is less than the first nominal value by the first predetermined amount.

3. (Original) The method of claim 1, further comprising the steps of:

monitoring the voltage at a midpoint between the two battery packs during float charging of the battery packs;

comparing the voltage to a second nominal value for the midpoint voltage during the float charging of the battery packs;

indicating a lack of operational readiness of one of the two battery packs when the voltage at the midpoint varies from the second nominal value by a second predetermined amount.

4. (Original) The method of claim 3, wherein the step of indicating a lack of operational readiness of one of the two battery packs comprises the step of indicating a lack of operational readiness of a first one of the two battery packs when the voltage at the midpoint is greater than the second nominal value by the second predetermined amount.

5. (Original) The method of claim 3, wherein the step of indicating a lack of operational readiness of one of the two battery packs comprises the step of indicating a lack of operational readiness of a second one of the two battery packs when the voltage at the midpoint is less than the second nominal value by the second predetermined amount.

6. (Original) The method of claim 3, wherein the UPS system includes a plurality of battery channels coupled in parallel with one another, and wherein the step of monitoring comprises the step of monitoring a voltage for each of the parallel coupled battery channels at a midpoint between the two battery packs during the float charging, the method further comprising the steps of:

calculating the second nominal value for the midpoint voltage during the float charging of the battery packs as the average of the voltages monitored for each parallel coupled battery channel; and

indicating a lack of operational readiness of a battery channel when the voltage at the midpoint of the battery packs for that channel varies from the second nominal value by the second predetermined amount.

7. (Original) The method of claim 6, wherein the step of indicating a lack of operational readiness of a battery channel comprises the step of indicating a lack of operational readiness of a first one of the two battery packs of that battery channel when the voltage at the midpoint is greater than the second nominal value by the second predetermined amount.

8. (Previously Presented) The method of claim 6, wherein the step of indicating a lack of operational readiness of a battery channel comprises the step of indicating a lack of operational readiness of a second one of the two battery packs of that battery channel when the voltage at the midpoint is less than the second nominal value by the second predetermined amount.

9. (Original) The method of claim 1, further comprising the steps of:

monitoring the voltage at a midpoint between the two battery packs at a state of discharge of the battery packs;

comparing the voltage to a third nominal value for the midpoint voltage during the state of discharge of the battery packs;

indicating a lack of operational readiness of one of the two battery packs when the voltage at the midpoint varies from the third nominal value by a third predetermined amount.

10. (Original) The method of claim 9, wherein the step of indicating a lack of operational readiness of one of the two battery packs comprises the step of indicating a lack of operational readiness of a first one of the two battery packs when the voltage at the midpoint is less than the third nominal value by the third predetermined amount.

11. (Original) The method of claim 9, wherein the step of indicating a lack of operational readiness of one of the two battery packs comprises the step of indicating a lack of operational readiness of a second one of the two battery packs when the voltage at the midpoint is greater than the third nominal value by the third predetermined amount.

12. (Original) The method of claim 9, wherein the UPS system includes a plurality of battery channels coupled in parallel with one another, and wherein the step of monitoring comprises the step of monitoring a voltage for each of the parallel coupled battery channels at a midpoint between the two battery packs during the state of discharge, the method further comprising the steps of:

calculating the third nominal value for the midpoint voltage during the state of discharge of the battery packs as the average of the voltages monitored for each parallel coupled battery channel; and

indicating a lack of operational readiness of a battery channel when the voltage at the midpoint of the battery packs for that channel varies from the third nominal value by the third predetermined amount.

13. (Original) The method of claim 12, wherein the step of indicating a lack of operational readiness of a battery channel comprises the step of indicating a lack of operational readiness of a first one of the two battery packs of that battery channel when the voltage at the midpoint is less than the third nominal value by the third predetermined amount.

14. (Original) The method of claim 12, wherein the step of indicating a lack of operational readiness of a battery channel comprises the step of indicating a lack of operational readiness of a second one of the two battery packs of that battery channel when the voltage at the midpoint is greater than the third nominal value by the third predetermined amount.

15. (Original) A method of detecting and identifying a failed battery pack in an uninterruptible power supply (UPS) system, the UPS system having a plurality of parallel connected slots into which may be coupled battery packs, power modules, or battery chargers as determined and configured by a user, the slots being adapted to accommodate two battery packs and providing a series coupling therebetween, the method comprising the steps of:

detecting a presence and type of equipment installed in each slot;

monitoring a voltage present at the series coupling between the two battery packs for each slot into which is installed battery packs;

calculating an average midpoint voltage for all slots having battery packs installed therein;

comparing the voltage for each slot to the average midpoint voltage for all slots; and

identifying a failed battery pack within a slot when the voltage for its associated slot deviates from the average midpoint voltage by a predetermined amount.

16. (Original) The method of claim 15, further comprising the steps of:
comparing the voltage for each slot to a predetermined expected value; and
identifying a failed battery pack within a slot when the voltage for its associated slot deviates from the predetermined expected value by a predetermined amount.

17. (Currently Amended) The method of claim 16, further comprising the step of determining an operating mode of the battery packs, and wherein the step of comparing the voltage for each slot to ~~a predetermined expected value~~the predetermined expected value comprises the step of comparing the voltage for each slot to an operating mode specific predetermined expected value, and wherein the step of identifying a failed battery pack within a slot when the voltage for its associated slot deviates from the predetermined expected value by ~~a predetermined amount~~the predetermined amount comprises the step of identifying a failed battery pack within a slot when the voltage for its associated slot deviates from the operating mode specific predetermined expected value by ~~a predetermined amount~~the predetermined amount.

18. (Original) The method of claim 17, wherein the step of determining an operating mode of the battery packs determines that the battery packs are operating in a quiescent mode, and wherein the step of identifying a failed battery pack within a slot comprises the step of identifying both battery packs as failed when the voltage for their associated slot is less than a first predetermined value by a first predetermined amount.

19. (Original) The method of claim 17, wherein the step of determining an operating mode of the battery packs determines that the battery packs are operating in a float charging mode, and wherein the step of identifying a failed battery pack within a slot comprises the step of identifying a first one of the two battery packs within the slot as failed when the voltage for its associated slot is less than a second predetermined value by a second predetermined amount, and identifying a second one of the two battery packs within the slot as failed when the voltage for its associated slot is greater than a third predetermined value by a third predetermined amount.

20. (Original) The method of claim 17, wherein the step of determining an operating mode of the battery packs determines that the battery packs are operating in a discharging mode, and wherein the step of identifying a failed battery pack within a slot comprises the step of identifying a first one of the two battery packs within the slot as failed

when the voltage for its associated slot is less than a fourth predetermined value by a fourth predetermined amount, and identifying a second one of the two battery packs within the slot as failed when the voltage for its associated slot is greater than a fifth predetermined value by a fifth predetermined amount.

21. (Original) The method of claim 15, wherein the step of detecting a presence and type of equipment installed in each slot comprises the step of polling each slot for an equipment type identifier.

22. (Original) A system for detecting defective battery packs in a modular, redundant uninterruptible power supply (UPS) system, the UPS system having a plurality of parallel connected slots into which may be coupled the battery packs, power modules, or battery chargers as determined and configured by a user, each slot being adapted to accommodate two battery packs and to provide a series coupling therebetween, the system comprising:

a voltage sense circuit coupled to each series coupling of each slot and operable to generate a voltage sense signal in response to a voltage present thereon;

a voltage sense selector circuit coupled to each of the voltage sense circuits, the voltage sense selector circuit operable to selectively enable the voltage sense circuits;

a controller operably coupled to the voltage sense selector circuit to command the voltage sense selector circuit to enable of a particular voltage sense circuit for a particular slot, the controller reading the voltage sense signal for the particular slot from the voltage sense circuit; and

wherein said controller compares the voltage sense signal for the particular slot to a predetermined expected value and identifies an operational status of the battery packs based thereon.

23. (Original) The system of claim 22, wherein the controller reads the voltage sense signal for each slot in which battery packs are installed, calculates an average voltage value, and compares the voltage sense signal for each slot to the average voltage value to identify the operational status of the battery packs for each slot.

24. (Currently Amended) The system of claim 23, wherein the controller reads the voltage sense signal for each slot in which battery packs are installed during a float charge mode, compares the voltage sense signal for each slot to an expected voltage value for the

float charge mode, and identifies a first one of the battery packs in a slot as defective when the voltage sense signal for ~~the associated slot~~an associated slot is less than the expected voltage value for the float charge mode, and identifies a second one of the battery packs in a slot as defective when the voltage sense signal for the associated slot is greater than the expected voltage value for the float charge mode.

25. (Currently Amended) The system of claim 23, wherein the controller reads the voltage sense signal for each slot in which battery packs are installed during a discharge mode, compares the voltage sense signal for each slot to an expected voltage value for the discharge mode, and identifies a first one of the battery packs in a slot as defective when the voltage sense signal for ~~the associated slot~~an associated slot is less than the expected voltage value for the discharge mode, and identifies a second one of the battery packs in a slot as defective when the voltage sense signal for the associated slot is greater than the expected voltage value for the discharge mode.

26. (Original) The system of claim 22, wherein the voltage sense selector circuit comprises a shift register having a clock input and a slot select input from the controller, the shift register sequentially generating a plurality of output enable signals in response to the clock input and the slot select input from the controller, each of the output enable signals operative to turn on a switching element to connect the voltage sense circuit to the controller.

27. (Original) The system of claim 26, wherein the switching element is a metal oxide silicon field effect transistor (MOSFET).

28.-59. (Canceled)